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ABSTRACT

This manual contains instructional worksheets for a course in basic laboratory skills. It has been designed to meet the needs of the treatment plant technician who has little or no previous laboratory experience and is required to monitor effluent discharges. The manual is prepared on a modular basis and includes basic mathematics, weighing techniques, use of equipment, solution preparation, and basic microbiological techniques. All handout sheets, pre- and post-tests, and quizzes are contained in the Appendix. (CS)

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Self-Monitoring Procedures: Basic Laboratory Skills

ED161699

STAFF GUIDE

SE 025 138

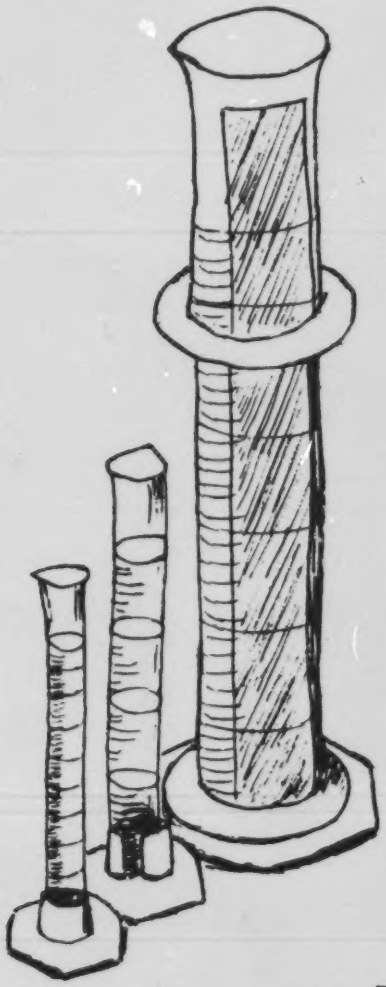
U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAM OPERATIONS

2

SELF-MONITORING PROCEDURES

BASIC LABORATORY SKILLS

INSTRUCTIONAL PACKAGE WORKSHEETS



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Preface

This manual contains the Instructional Package Worksheets for the presentation of Course I Basic Laboratory Skills. This course is designed for the treatment plant operator or technician who is required to monitor effluent discharges under a National Pollutant Discharge Elimination System (NPDES) permit and who has had little or no previous experience in laboratory work.

The course will include a review of basic mathematics. Applications in the chemical laboratory such as weighing techniques, use of equipment and solution preparation will be stressed. An introduction to basic microbiological techniques will also be included.

The manual has been prepared on a modular basis with all the necessary information contained within to satisfactorily present the course. The modular form is based on availability of adequate staff and prescreening tools. It is designed for the use of the instructor. All handout sheets, pre and post tests, as well as pertinent quizzes are contained in the Appendix. All Appendix materials are designed to be duplicated whenever applicable.

All available media is listed in Appendix III and numerically coded. These numbers coincide in part with Volume II Instructional Materials Available, Environmental Protection Agency, Charles County Community College, 1974.

Several video tape cassettes have been developed by the Environmental Protection Agency, National Training Center in Cincinnati, Ohio. It is recommended that these cassettes be utilized as soon as they are available. A partial list is included at the end of Appendix II.

DISCLAIMER

Reference to commercial products, trade names, and manufacturers is for purposes of example and illustration. Such references do not constitute endorsement by the Charles County Community College or the U. S. Environmental Protection Agency.

EFFLUENT MONITORING PROCEDURES

COURSE - I BASIC LABORATORY SKILLS

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SUMMARY INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Self-Monitoring Procedures:
Course I - Basic Laboratory Skills

UNIT OF INSTRUCTION: Total 4

ESTIMATED TIME: 31 Hours

JUSTIFICATION: In accordance with the National Pollutant Discharge Elimination System (NPDES), five basic parameters and others as designated by state agencies are required for reporting purposes by all wastewater treatment facilities. The basic laboratory skills necessary to satisfactorily determine these parameters are included in this package.

ENTRY LEVEL BEHAVIOR: The individual must have completed the acceptable registration form as shown in Appendix I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will satisfactorily complete all modules of instruction.

2. Conditions - Classroom instruction and demonstration. Laboratory practicum with instructor supervision utilizing supplies as designated in the lesson.

3. Accepted Performance - Satisfactory completion of individual modules as stated in checklists (See Appendix II).

B. INSTRUCTIONAL RESOURCES

1. Available Media - See Appendix III

2. Suggested Media - Slides, overheads and video tape cassettes showing laboratory equipment and specific procedures.

C. INSTRUCTIONAL APPROACH

Module	I - Basic Mathematics	(3 Hours)
Module	II - Chemical Laboratory	(23 Hours)
Module	III - Microbiology	(4 Hours)
Module	IV - Laboratory Inventory	(1 Hour)

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Summary of Instruction on Mathematics

LESSON NUMBER: Total 5

ESTIMATED TIME: 3 Hours

JUSTIFICATION: NPDES Report Form requires Mathematical calculations.

ENTRY LEVEL BEHAVIOR: Student must have completed registration form.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will satisfactorily complete the five units of instruction on Basic Mathematics.

2. Conditions - Oral and written presentation with use of handouts.

3. Accepted Performance - 90% of the tested material 100% correct.

B. INSTRUCTIONAL RESOURCES

1. Available Media

239	519	689	2008	3024
442	620	2002	3009	
476	627	2007	3014	

2. Suggested Media

Wall chart on the Metric System

C. INSTRUCTIONAL APPROACH (SEQUENCING)

A pre-test (Appendix IV) covering Lessons I-V will be given at the beginning of this unit. Satisfactory completion of this pretest allows student to omit these lessons.

Lesson	I - Metric System	(30 Minutes)
Lesson	II - Whole Numbers	(30 Minutes)
Lesson	III - Decimals	(30 Minutes)
Lesson	IV - Formulas	(30 Minutes)
Lesson	V - Percentages	(30 Minutes)

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Metric System

LESSON NUMBER: 1 of 5

ESTIMATED TIME: 30 Minutes

JUSTIFICATION: The results of the following analyses: Suspended Solids, Dissolved Oxygen, Biochemical Oxygen Demand, and Chlorine Residual, are always expressed in units of the metric system.

ENTRY LEVEL BEHAVIOR: Student must have completed registration form.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

a. Name the metric and English terms for:

1) mass
2) volume
3) temperature

b. State the numerical value for the following metric prefixes:

1) kilo
2) milli

2. Conditions - Written or oral presentation from recall

3. Accepted Performance - 80% of the tested material 100% correct.

B. INSTRUCTIONAL RESOURCES

1. Available Media

Metric Conversion Table
Wall chart of the Metric System

388
2003
3010
3014

2. Suggested Media - None

C. INSTRUCTOR ACTIVITY

1. Develop the idea that the metric system is a measurement system based on the number 10. Also include where the metric system is used and the gradual conversion of the United States (English System) to the Metric System.

2. Illustrate the relationships between the Metric and English Systems.

Measurement	Metric	English
e.g. Mass or weight	milligrams, grams, kilograms	Ounces, pounds tons
Length	centimeter, millimeter, meter, kilometer	inches, feet, yard, mile
Volume	milliliter liter	pints, quarts, gallons
Temperature	Centigrade(°C)	Fahrenheit(°F)

3. Emphasize that numerical conversions are not necessary for this laboratory work. If they need to be done, use the conversion card. To illustrate this, conversion cards may be handed out at this time. Show the numerical relationships between the two systems using temperature as an example.

Examples of common numerical conversions are as follows:

1 pound (lb) = 453 gram (g)
1 inch (in) = 2.54 centimeter (cm)
1 quart (qt) ≈ 1 liter (l)

4. Illustrate the following relationships of the numerical value for the metric prefixes.

Kilo	=	1000
Centi	=	1/100 or 0.01
Milli	=	1/1000 or 0.001

Examples are:

1000 meters	=	kilometer
1000 milligrams	=	1 gram
1000 ml	=	1 liter
1000 mm	=	1 meter

5. Give quiz I (See Appendix V).
If student does not meet accepted performance supplementary work from a specific reference will be given.

D. Student Activity

1. Work examples given and discuss any problems.

2. Complete Quiz I at end of lecture (See Appendix V).

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Whole Numbers

LESSON NUMBER 2 of 5

ESTIMATED TIME: 30 minutes

JUSTIFICATION: Mathematical operations involving whole numbers are used in the gravimetric and volumetric analyses involved in the five basic parameters.

ENTRY LEVEL BEHAVIOR: Completion of Lesson 1 of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Using whole numbers the student will add, subtract, multiply and divide including the following operations:

   a. Rounding off to the nearest specific value (tens, hundreds and thousands).

   b. Using only 2 numbers (e.g.)

221 gms	143 ml
+72 gms	-28 ml

   (82) (205) or 82 x 205

   221/16

   c. Using 3 numbers (multiplication only)

   (82) (12) (16) or 82 x 12 x 16

2. Conditions - Written and/or oral presentation from recall.

3. Accepted Performance - 90% of tested material 100% correct.

B. INSTRUCTIONAL RESOURCES

1. Available Media

239	620	2008
442	689	3009
476	2002	3014
519	2007	3024

2. Suggested Media - None

C. INSTRUCTOR ACTIVITY

1. Demonstrate the basic mathematical operations. It is recommended that additional examples be shown. These may be done either with a worksheet or at the blackboard.

e.g.

Addition:

$$\begin{array}{r} 42 \text{ gms} \\ +\ 6 \text{ gms} \\ \hline 48 \text{ gms} \end{array}$$

Subtraction:

$$\begin{array}{r} 50 \text{ ml} \\ -12 \text{ ml} \\ \hline 38 \text{ ml} \end{array}$$

Multiplication:

$$62 \text{ ml} \times 10 = 620 \text{ ml}$$

Division:

200g/40 means

$$40\overline{)200}^{\,5}$$ or 5 gms.

2. Demonstrate the process of rounding off whole numbers, using examples of balance accuracy and buret accuracy.

a. Explain the decimal system of numbers, to include the value of each position through millions.

b. Give the following rules with examples:

RULES FOR ROUNDING OFF NUMBERS:

1) When the first digit after those being retained is less than 5, all digits retained remain the same.

EXAMPLE:

Round 912 to the nearest ten:

Answer 910

2) When the first digit after those being retained is larger than 5, the last digit is rounded off by increasing it one number.
EXAMPLE:

Round 47 to the nearest ten.
Answer 50.

3) When the first digit after those being retained is 5, the last digit retained is rounded off by increasing it one number.
EXAMPLE:

Round 65 to the nearest ten.
Answer: 70.

Round 75 to the nearest ten.
Answer 80.

(a) Give additional examples such as:

Round the following numbers to the nearest hundred.

847 ------> 800
75,619 ------> 75,600

Round the following numbers to the nearest thousand.

16,945 ------> 17,000
843,228 ------> 843,000

Numbers with units may be used in this exercise.

3. Give Quiz (II - Appendix V).
If the student does not meet the accepted performance, supplementary work from a specific reference (Appendix III) should be given.

D. STUDENT ACTIVITY

1. Work examples given and discuss any problems.

2. Complete Quiz II at end of lecture (See Appendix V).

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Decimals

LESSON NUMBER: 3 of 5

ESTIMATED TIME: 30 Minutes

JUSTIFICATION: Mathematical operations involving decimals are used in the gravimetric and volumetric analysis involved in the five basic parameters.

ENTRY LEVEL BEHAVIOR: Completion of Lesson 1 of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

a. Differentiate between decimals and whole numbers.

b. Write a specified decimal number.

c. Add, subtract, multiply and divide decimal numbers.
e.g.

Only two numbers:

addition 4.793 + 0.921
subtraction 4.793 - 3.921
multiplication (1.21) (0.92) or 1.21 x 0.92
division 1.73/2.1

d. Round off to the nearest specified value,
e.g.

4.670 to the nearest tenth
0.2598 to the nearest hundredth
26.0403 to the nearest thousandth

2. Conditions - Written/or oral presentation from recall.

3. Accepted Performance - 90% of the tested material 100% correct.

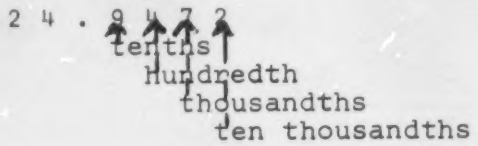
B. INSTRUCTIONAL RESOURCES

239	620	2007	3024
442	627	2008	
476	689	3009	
519	2002	3014	

2. Suggested Media - None.

C. INSTRUCTOR ACTIVITY

1. Illustrate tenths, hundredths, thousandths, and ten thousandths in the following number.



2. Given a list of decimals and whole numbers, differentiate between them.

3. Write orally specified decimal numbers.

4. Apply the basic mathematical operations, covered in lesson 2, to decimals. Again it is recommended that additional examples be shown either with a worksheet or at the blackboard.

Addition:		Subtraction	
4.6701	gms.	48.5	ml
+ 0.743	gms.	- 19.7	ml
5.4131	gms.	28.8	ml

Multiplication: 24.62 gms x 100 = 2462 gms

Division: 36.85 gms/8.9 = 4.14 gms.

5. Apply the rules of rounding off whole numbers to decimals.

Illustrate the rules of lesson 2 by using the following examples:

Round off to the nearest tenth:

4.1073 ------> 4.1
8.47 ------> 8.5

Round off to the nearest thousandth:

80.5123 -----> 80.512
0.00754 -----> 0.008

6. Give Quiz.
If the student does not meet the accepted performance, supplementary work from a specific reference should be given (Appendix III).

D. STUDENT ACTIVITY

1. Work examples given and discuss any problems.

2. Complete Quiz III at the end of lecture (See Appendix V).

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Formulas

LESSON NUMBER: 4 of 5

JUSTIFICATION: Formulas are used to calculate the results of the Dissolved Oxygen and Biochemical Oxygen Demand and the Suspended Solids analyses.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1, 2 and 3 of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will solve the following types of formulas:

a. $A = B \times C$

b. $A = \frac{B \times C}{D}$

c. $A = \frac{(B-C)\ (1000)}{D}$

Where A, B, C, and D may be whole numbers or decimals and B, C and/or D are data bits.

2. Conditions - From recall of oral and written presentation.

3. Accepted Performance - 80% of tested material 100% correct.

B. INSTRUCTIONAL RESOURCES

1. Available Media

239	620	2007	3024
442	627	2008	
476	689	3009	
519	2002	3014	

2. Suggested Media - None.

C. INSTRUCTOR ACTIVITY

1. Show examples of mixed operations.

C. INSTRUCTOR ACTIVITY con't.

$6 \times 4/2 = \underline{12}$ $\quad (16.4 - 3.2)/5 = \underline{2.6}$

Additional examples of these mixed operations should be given.

2. Show the relationship of mixed operations to formula solving. Include cancellation of units.

Solids Analysis:

$$A = \frac{(B-C)\ (1000)}{D}$$

Where A = mg/liter suspended solids
B = Final Weight in mg
C = Initial Weight in mg
1000 = Constant (Define)
D = ml sample filtered

Sample Data

B = 24.7369 g = 24,736.9 mg
C = 24.7201 g = 24,720.1 mg
D = 50 ml

$$A = \frac{(24{,}736.9 \text{ mg} - 24{,}720.1 \text{ mg})\ (1000)\text{ml/liter}}{50 \text{ ml}}$$

$$A = \frac{(16.8 \text{ mg})\ (1000 \cancel{\text{ml}})}{50 \cancel{\text{ml}} \times \text{liter}}$$

$$A = \frac{(16.8 \text{ mg})\ (20)}{\text{liter}}$$

A = 336 mg/liter Concentration terms will be explained later.

Dissolved Oxygen

$$A = \frac{B \times C}{D}$$

Where A = normality of sodium thiosulfate
B = ml of biiodate
C = normality of biiodate
D = ml of sodium thiosulfate

See additional examples in student reference manual.

Instructor note: The term normality and compound names should be omitted at this time.

2. con't.

The symbol N, and the term ml may be used.

Sample Data

B = 20.0 ml
C = 0.0375 N
D = 18.8 ml

$$A = \frac{B \times C}{D}$$

$$= \frac{20.0 \text{ ml} \times 0.0375 \text{ N}}{18.8 \text{ ml}}$$

$$= \frac{0.75 \text{ N}}{18.8}$$

$$= 0.0394 \text{ N}$$

3. Give Quiz.
If the student does not meet the accepted performance, supplementary work from a suitable reference should be given (See Appendix III).

D. STUDENT ACTIVITY

1. Work examples given and discuss any problems.

2. Complete Quiz IV at end of lecture (See Appendix V).

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Basic Mathematics

UNIT OF INSTRUCTION: Percentage

LESSON NUMBER: 5 of 5

ESTIMATED TIME: 30 minutes

JUSTIFICATION: A calculation of percent removal of Biochemical Oxygen Demand and suspended solids is necessary in completion of the Discharge Monitoring Report.

ENTRY LEVEL BEHAVIOR: Completion of lessons 1, 2, 3, and 4 of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will solve the following percent removal problems to the nearest whole percent.

a. $$\% \text{ Removal BOD} = \frac{BOD_i - BOD_f}{BOD_i} \times 100$$

b. $$\% \text{ Removal Suspended Solids} = \frac{S.S._i - S.S._f}{S.S._i} \times 100$$

2. Conditions - From recall of oral and written presentation.

3. Accepted Performance - 80% of tested material 100 % correct.

B. INSTRUCTIONAL RESOURCES

1. Available Media

239	620	2007	3024
442	627	2008	
476	689	3009	
519	2002	3014	

2. Suggested Media - None

C. INSTRUCTOR ACTIVITY

1. Develop the concept that the phrase per hundred and percent have exactly the same meaning.

C. INSTRUCTOR ACTIVITY con't.

a. 30/100 = 30 hits per hundred times at bat or 30 percent.

b. 150/300 = 150 bullseyes in 300 shots or 50 bullseyes per hundred shots or 50 percent.

Additional examples of these relationships should be given.

2. Show that the symbol "%" can be used instead of the word percent.

Examples:

a. 49 percent or 49%

b. 65 percent or 65%

3. Show that a decimal can be converted to a percent by multiplying it by 100.

Examples:

a. .72 x 100 = 72%
b. .92 x 100 = 92%

4. Illustrate the use of percentages in percent removal problems.

Examples:

a. % Removal BOD = $\frac{BOD_i - BOD_f}{BOD_i} \times 100$

Where BOD_i = 278 mg/l
BOD_f = 10 mg/l

% Removal = $\frac{278 - 10}{278} \times 100$

= $\frac{268}{278} \times 100$

= .96 x 100 = 96%

b. % Removal Suspended Solids = $\frac{S.S._i - S.S._f}{S.S._i} \times 100$

Where $S.S._i$ = 210 mg/l
$S.S._f$ = 28 mg/l

b. Con't.

$$\% \text{ Removal} = \frac{210 - 28}{210} \times 100$$

$$= \frac{182}{210} \times 100$$

$$= .87 \times 100 = 87\%$$

5. Give Quiz.
   If the student does not meet the accepted performance, supplementary work from a suitable reference should be given. (See Appendix III).

D. STUDENT ACTIVITY

1. Work examples given and discuss any problems.

2. Complete Quiz V at end of lecture (See Appendix V).

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Summary of Instruction on the Chemical Laboratory

LESSON NUMBER: Total 9

ESTIMATED TIME: 23 Hours.

JUSTIFICATION: Chemical analyses are required in the NPDES.

ENTRY LEVEL BEHAVIOR: Completion of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will satisfactorily complete the nine units of instruction of the Chemical Laboratory.

2. Conditions - Given a lab with all necessary equipment, classroom instruction and laboratory demonstrations where appropriate.

3. Accepted Performance - Satisfactory performance in the laboratory as measured by the instructor check lists.

B. INSTRUCTIONAL RESOURCES

1. Available Media

4	443	669	2012	3014	3020	3028
204	447	2000	2013	3015	3021	
285	507	2004	2016	3016	3022	
289	534	2005	3001	3017	3023	
367	594	2009	3012	3018	3025	
404	671	2011	3013	3019	3027	

2. Suggested Media

Video Tape presentations of specific laboratory procedures.

C. INSTRUCTIONAL APPROACH (SEQUENCING)

Lesson I - Safety (1 Hour)
Lesson II - Bench Sheets/Notebooks (30 Minutes)

C. INSTRUCTIONAL APPROACH (SEQUENCING) con't.

Lesson	III	- Labeling	(30 Minutes)
Lesson	IV	- Names and formulas of Compounds	(3 Hours)
Lesson	V	- Care & Use of Equipment	(2 Hours)
Lesson	VI	- Matter	(2 Hours)
Lesson	VII	- Solutions	(1 Hour)
Lesson	VIII	- Use of Laboratory Balances	(4 Hours)
Lesson	IX	- Volumetric Analysis	(9 Hours)

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Safety

LESSON NUMBER: 1 of 9

ESTIMATED TIME: 1 Hour

JUSTIFICATION: According to state law and the Occupational Safety and Health Act (OSHA), proper safety procedures must be exercised at all times in the laboratory.

ENTRY LEVEL BEHAVIOR: Completion of Module I.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

a. Locate the following in the laboratory:

1) Safety Shower
2) Fire Extinguisher
3) Fire Blanket
4) Eye Wash
5) First Aid Kit and Instruction Sheet
6) Fume Hood

b. Demonstrate the use of the equipment.

c. Select the proper pieces of equipment given an emergency situation.

d. State when safety glasses and laboratory aprons will be used.

2. Conditions - Given a laboratory with all necessary safety equipment. Oral presentation with demonstration of all equipment.

3. Accepted Performance - Satisfactory completion of oral or written quiz (100%),

B. INSTRUCTIONAL RESOURCES

1. Available Media

4	699	2005	3014	3016	3018	3020	3022
367	2004	2009	3015	3017	3019	3021	3023

2. Suggested Media

New film on safety in the Chemistry Laboratory.
Video Tape on student response of emergency situations.

C. INSTRUCTOR ACTIVITY

The student should be in the laboratory for this presentation.

1. Show the locations of the following safety devices and illustrate their use.

   a. Safety Shower
   b. Fire Extinguisher
   c. Fire Blanket
   d. Eye Wash
   e. First Aid Kit and Instruction Sheet
   f. Fume Hood

2. Pose several different emergency situations and tell student how he should handle it. The following examples may be used:

   a. Your lab partner has splashed sulfuric acid in his eyes.

      Use Eye Wash or Safety Shower.

   b. You are heating a solution and your shirt catches fire. What do you do?

      Use Fire Extinguisher, Fire Blanket, or Safety Shower.

3. An unannounced emergency situation during the next laboratory sections would be advantageous. Additional examples may be used at this time.

4. The safety regulations of the laboratory should be covered.

   a. Wear protective goggles or eye glasses at <u>all</u> times in the laboratory.

   b. Flush corrosive liquid from the eye with plenty of water or, preferably, with sterile isotonic solution.

c. If corrosive liquids touch the skin, flood with water. Consult your instructor.

d. Do not hold face directly over a container when noting the odor. Instead, fan a little of the vapor toward your nostrils by sweeping your hand over the top of the container.

e. For reactions involving poisonous gases, use the hood, which provides suction to remove such gases or vapors.

f. When diluting any concentrated acid especially sulfuric acid, pour the acid slowly into the water, never reverse the order. So much heat is liberated on solution that steam may form with explosive violence.

g. Leave reagent bottles on the front chemical table. Bring test tubes or beakers to the shelf for transferring chemicals and carrying them to your desk.

h. Read the label twice before taking anything from the bottle, noting chemical name, formula, and applicable safety precautions.

i. Never return unused chemicals to the stock bottle.

j. Do not insert your own pipets or medicine droppers into the reagent bottles.

k. Do not lay the stopper of the bottle down in such a manner that it picks up impurities.

l. Do not heat heavy glassware such as volumetric flasks, graduated cylinders, or bottles; they break easily.

NOTE: These regulations may change from lab to lab.

D. STUDENT ACTIVITY

1. Take part in discussion of safety regulations and equipment.

2. Perform as called upon to demonstrate ability to handle an emergency situation.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Bench Sheets/Notebooks

LESSON NUMBER: 2 of 9

ESTIMATED TIME: 30 Minutes

JUSTIFICATION: Bench sheets and notebooks are used to keep a permanent record of laboratory information in a logical order.

ENTRY LEVEL BEHAVIOR: Student must have completed registration form.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

a. Describe the utility of a laboratory bench sheet.

b. Complete sample bench sheets with the appropriate information to include:

1) Date
2) Sample Description
3) Equipment number or designation
4) Raw data - weight, sample volume, etc.
5) Results

c. Describe information to be included in a general laboratory notebook.

2. Conditions - Given a description of the analysis being performed, sample data, bench sheet, and formulas for calculating the results and instructor assistance.

3. Accepted Performance - Satisfactory response to oral questions and completion of a sample bench sheet.

B. INSTRUCTIONAL RESOURCES

1. Available Media

699 3014
2004
3001

29

2. Suggested Media - None

C. INSTRUCTOR ACTIVITY

1. Handout a laboratory notebook.

2. Emphasize the necessity of up-to-date records.

3. Explain the general information on a bench sheet.

   a. Date
   b. Sample Designation
   c. Equipment designation
   d. Raw data - weights, volume of sample, amount of titrant.
   e. Results

4. Complete sample bench sheet (page 29) from the information in the student reference manual.

5. Explain the general information in a notebook.

   a. Date/Procedure/Name
   b. Sample Designation
   c. Equipment Designation
   d. Initial and final weights
   e. Volume of liquid
   f. Initial/Final/Elapsed Time
   g. Observations of Abnormal Conditions
   h. Calculation
   i. Results

   See sample laboratory record page 28.

D. STUDENT ACTIVITY

1. Take notes on material presented.

2. Complete sample bench sheets.

Sample Laboratory Record

7/22/74 - Standard Potassium Biiodate
Solution from D.O. Analysis
(Stock Solution)

Final wt. of beaker	28.2802 g
Initial wt. of beaker	- 25.0312 g
Wt. of Biiodate	3.2490 g

Volume of water - 1 liter

Concentration of solution 3.2490 g/1 or 0.100 N

Sample Laboratory Record

7/22/74 Settleable Solids Analysis

Primary Influent - Cone # 1 Start at 10:25 1 Hour
Stop at 11:25

1 liter sample
Result - 5 ml/l

Final Effluent - Cone #5 Start at 10:30 1 Hour
Stop at 11:30

1 liter sample
Result - no settleable solids

BENCH SHEET B.O.D. DETERMINATIONS

SAMPLE SOURCE & DATE COLLECTED	DATE IN	DATE OUT	BOTTLE NO.	INITIAL D.O.	FINAL D.O.	DEPLETION mg/l	% DIL.	B.O.D. mg/l

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Labeling

LESSON NUMBER 3 of 9

ESTIMATED TIME: 30 Minutes

JUSTIFICATION: All chemical analyses require proper reagent, equipment and labeling.

ENTRY LEVEL BEHAVIOR: Completion of lesson 2, Module 2.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

a. Describe the necessity of proper labeling of chemical stock bottles, beakers, flasks, etc.

b. State the information required on a chemical stock bottle.

c. State the information required on beakers, flasks, etc., containing in-process chemicals.

d. Select the proper instrument for writing on porcelain and glass.

e. Prepare a label for a chemical stock bottle.

2. Conditions - Given an oral presentation with use of labels, and a list of information to be put in label format.

3. Accepted Performance - Satisfactory response to oral questions and completion of a label for a chemical stock bottle.

B. INSTRUCTIONAL RESOURCES

1. Available Media

699	3014
2004	
3001	

2. Suggested Media - None

C. INSTRUCTOR ACTIVITY

1. Illustrate the purpose of proper labeling of stock bottles, containers and In-Process Chemicals. Emphasize safety and convenience.

2. Illustrate the following labeling techniques.

   a. Commercial or pre-gummed
   b. Homemade
   c. Use of Grease Pencils
   d. Use of Lead Pencils
   e. Labeling Gooch Crucibles
   f. Labeling MPN Tubes
   g. Use of Water Soluble Markers should be covered at this time.

3. Show the information required on the labels.

Chemical Name Chemical Formula Concentration	
Date	Initials

EXAMPLE

Sodium Chloride NaCl 0.1 N	
7/23/74	J.H.H.

D. STUDENT ACTIVITY

1. Take notes on material presented.

2. Complete a sample label as directed.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Names & Formulas of Compounds

LESSON NUMBER: 4 of 9

ESTIMATED TIME: 3 Hours

JUSTIFICATION: In preparation and standardization of reagents it is necessary to identify chemicals by formula and name.

ENTRY LEVEL BEHAVIOR: Completion of Lesson 3, Module 2.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will identify and choose the correct chemicals necessary for an analysis by name and formula.

2. Conditions - Given a laboratory with all necessary chemicals and various lists of consumable supplies.

3. Accepted Performance - Completion of a given check list with 100% accuracy.

B. INSTRUCTIONAL RESOURCES

1. Available Media

4	671	3014
204	2000	
534	2004	
594	2005	

2. Suggested Media - None.

C. INSTRUCTOR ACTIVITY

1. Cite the importance of using specific chemicals in certain analyses. It must be emphasized that the correct chemical must be chosen for any analysis with 100% accuracy.

2. The importance of the name of the chemical must be stressed giving the following examples:

   a. Minor spelling variations
   b. The word "anhydrous"
   c. Mesh sizes
   d. The words dilute and concentrated

D. STUDENT ACTIVITY

1. The student should complete Check-List I and II as the directions state (pages 40 & 42).

E. INSTRUCTOR ACTIVITY

The importance of the chemical formula must be stressed giving the following examples.

a. Significance of letter and subscripts (H_2O)
b. Meaning of hydration coefficients ($Na_2S_2O_3 \cdot 5H_2O$)
c. Chemicals that have the same formula but different names such as K_3PO_4
   Tripotassium phosphate
   Potassium phosphate, tribasic
   Potassium ortho phosphate
d. Chemicals that have the same name but different formulas. Such as:
   Sodium Phosphate, monobasic
   $Na_2HPO_4 \cdot 2H_2O$
   $Na_2HPO_4 \cdot 7H_2O$
   $Na_2HPO_4 \cdot 12H_2O$

F. STUDENT ACTIVITY

1. The student should complete Check-List III and IV as the directions state (pages 44 & 46).

G. INSTRUCTOR ACTIVITY

1. The importance of the information contained on a label of a stock bottle must be stressed.

   a. Name
   b. Formula
   c. Cautions - Explosive, Hazards, Fire Hazard, storage requirements.
   d. Miscellaneous - Purity

H. STUDENT ACTIVITY

1. The student should be given a list of consumable supplies from any of the check-lists. He will then select the correct stock bottle from a given collection of bottles.

D. STUDENT ACTIVITY

2. It should be reemphasized that this portion of the lesson must be completed with 100% accuracy.

INSTRUCTOR NOTE:

Students may be rotated from one station to another to insure proper identification of all reagents.

A list of suggested reagents is shown on pages 35 - 38.

CHEMICAL REAGENTS

Table #1

$MnSO_4 \cdot H_2O$	Manganous Sulfate Monohydrate
NaI	Sodium Iodide
NaN_3	Sodium Azide
	Soluble Starch (Corn)
NaOH	Sodium Hydroxide (Pellets)
$Na_2S_2O_3 \cdot 5H_2O$	Sodium Thiosulfate Pentahydrate
$KH(IO_3)_2$	Potassium Bi-iodate (Potassium Acid Iodate)
KI	Potassium Iodide
$Na_2S_2O_3$	Sodium Thiosulfate Anhydrous
$MgSO_4 \cdot 7H_2O$	Magnesium Sulfate Heptahydrate
$NaIO_3$	Sodium Iodate
KIO_3	Potassium Iodate
NaOH in Solution (6N) Reagent	6N NaOH Sodium Hydroxide

CHEMICAL REAGENTS

Table #2

$MgSO_4 \cdot 7H_2O$	Magnesium Sulfate Heptahydrate
K_2HPO_4	Potassium Phosphate, Dibasic Dipotassium Hydrogen Phosphate
$FeCl_3 \cdot 6H_2O$	Ferric Chloride Hexahydrate
	Alkaline Iodide - Azide Reagent
$CaCl_2$	Calcium Chloride Anhydrous
$FeCl_2 \cdot 4H_2O$	Ferrous Chloride Tetrahydrate
Na_2HPO_4	Sodium Phosphate Dibasic - Anhydrous or Disodium Hydrogen Phosphate
KH_2PO_4	Potassium Phosphate Monobasic or Potassium Dihydrogen Phosphate
$Na_2HPO_4 \cdot 7H_2O$	Sodium Phosphate, Dibasic - Heptahydrate or Disodium Hydrogen Phosphate "
$Na_2HPO_3 \cdot 5H_2O$	Sodium Phosphite, Dibasic - Pentahydrate or Disodium Hydrogen Phosphite - "
$CaCl_2 \cdot 2H_2O$	Calcium Chloride Dihydrate
NH_4Cl	Ammonium Chloride
K_3PO_4	Potassium Phosphate, Tribasic

CHEMICAL REAGENTS

Table #3

KNO_3	Potassium Nitrate
KNO_2	Potassium Nitrite
HCl	Hydrochloric Acid (6N) Dilute
HCl	Hydrochloric Acid Concentrated
$NaAsO_2$	Sodium Arsenite (META)
$Na_2HAsO_4 \cdot 7H_2O$	Sodium Arsenate, Dibasic Heptahydrate or Disodium Hydrogen Arsenate Heptahydrate
NaCl	Sodium Chloride
NH_2SO_3H	Sulfamic Acid
$NH_2C_2HSO_3H \cdot H_2O$	Sulfanilic Acid

CHEMICAL REAGENTS

Table #4

C_2H_5OH (95%)	Ethyl Alcohol or Ethanol
Sulfuric Acid (6N)	Dilute H_2SO_4
Sulfuric Acid 18N	Concentrate
H_3BO_3	Boric Acid
HgO	Mercuric Oxide; red Mercuric Oxide; yellow
$Na_2S_2O_3$	Sodium Thiosulfate, Anhydrous
NaSCN	Sodium Thiocyanate
NaOH	Sodium Hydroxide (Pellets)
K_2SO_4	Potassium Sulfate
$K_2S_2O_7$	Potassium Pyrosulfate
Methylene Blue, Alcoholic Solution Staining and Powder	
Methyl Blue - Powder	
$C_{15}H_{15}N_3O_2$	Methyl Red - Solution and Powder Solution 0.02% in 60% Alcohol or (p) Para - Dimethylaminoazobenzene -O- Carboxlic Acid

CONSUMABLE SUPPLIES I

1. 480 g. manganous sulfate tetrahydrate, $MnSO_4 \cdot 4H_2O$
2. 500 g. sodium hydroxide, NaOH
3. 125 g. sodium iodide, NaI
4. 10 g. sodium azide, NaN_3
5. 4 plastic weighing boats
6. 1 small size spatula
7. 1 medium size spatula
8. 10 g. soluble starch
9. 10 ml chloroform
10. 186.15 g. sodium thiosulfate pentahydrate, $Na_2S_2O_3 \cdot 5H_2O$
11. 6 g. potassium biiodate (or potassium biniodate) $KH(IO_3)_2$
12. 3 g. potassium iodide, KI
13. 10 ml concentrated sulfuric acid, H_2SO_4
14. pen or pencil
15. paper (to record data)

CHECK LIST I

Chemical Names:

Place number from "consumable" list by matching name.

_____ a. Sodium Nitrate

_____ b. Sodium Thiosulfate, Anhydrous

_____ c. Sodium Thiosulfate Pentahydrate

_____ d. Carbon Tetrachloride

_____ 3. Manganese Hydroxide

_____ f. Manganous Sulfate Tetrahydrate

_____ g. Magnesium Sulfate Heptahydrate

_____ h. Potassium Bichromate

_____ i. Sodium Iodide

_____ j. Sodium Fluoride

_____ k. Potassium Biiodate

_____ l. Sodium Sulfite

_____ m. Sodium Thiosulfite

_____ n. Dilute Sulfuric Acid

_____ o. Sodium Azide

_____ p. Sodium Acetate

_____ q. Concentrated Sulfuric Acid

_____ r. Soluble Starch

CONSUMABLE SUPPLIES II

1. Small wad of cotton
2. 10 g. potassium dehydrogen phosphate, KH_2PO_4
3. 25 g. dipotassium hydrogen phosphate, $K2HPO_4$
4. 35 g. disodium hydrogen phosphate heptahydrate, $Na_2HPO_4 \cdot 7H_2O$
5. 3 g. ammonium chloride, NH_4Cl
6. 25 g. magnesium sulfate heptahydrate, $MgSO_4 \cdot 7H_2O$
7. 30 g. anhydrous calcium chloride $CaCl_2$
8. 1 g. ferric chloride, $FeCl_3$
9. Manganous sulfate solution*, alkaline iodide azide solution*, starch solution*, standard sodium thiosulfate solution*, and concentrated sulfuric acid*.
10. pen or pencil
11. paper (for recording data)
12. grease pencil

*As listed in the EMP on the Winkler Determination of Dissolved Oxygen Azide modification.

CHECK LIST II

Chemical Names:

Place number from "consumable" list by matching name.

_____ a. Calcium Chloride Dihydrate

_____ b. Sodium Chloride

_____ c. Ammonium Chloride

_____ d. Ferrous Chloride

_____ e. Potassium Dihydrogen Phosphate

_____ f. Magnesium Sulfate Heptahydrate

_____ g. Ammonium Chlorate

_____ h. Calcium Chloride, Anhydrous

_____ i. Ferric Chloride

_____ j. Dipotassium Hydrogen Phosphate

CONSUMABLE SUPPLIES III

1. 721.8 mg anhydrous potassium nitrate, KNO_3
2. 5.0 g sodium arsenite, $NaAsO_2$
3. 1 g brucine sulfate, $(C_{23}H_{26}N_2O_4)_2 \cdot H_2SO_4 \cdot 7H_2O$
4. 0.1 g sulfanilic acid, $NH_2C_6H_4SO_3H \cdot H_2O$
5. 3 ml concentrated hydrochloric acid, HCl
6. 500 ml concentrated sulfuric acid, H_2SO_4
7. 300 g sodium chloride, NaCl

CHECK LIST III

Chemical Formulae:

Place the number from the "consumable" list by the matching formula.

_____ a. KNO_2

_____ b. KCl

_____ c. HCl

_____ d. KNO_3

_____ e. $NaClO_3$

_____ f. $(C_{24}H_{28}N_2O_4) \cdot H_2SO_4 \cdot 7H_2O$

_____ g. $NaAsO_2$

_____ h. $(C_{23}H_{26}N_2O_4) \cdot H_2SO_4 \cdot 7H_2O$

_____ i. H_3PO_4

_____ j. $NH_2C_6H_4SO_3H \cdot H_2O$

_____ k. H_2SO_4

_____ l. $NaClO$

_____ m. $NaCl$

CONSUMABLE SUPPLIES IV

1. 134 g. potassium sulfate, K_2SO_4
2. 200 ml concentrated sulfuric acid, H_2SO_4
3. 2 g. red mercuric oxide, HgO
4. 25 ml 6N Sulfuric Acid, H_2SO_4
5. 500 g. sodium hydroxide, NaOH
6. 25 g. sodium thiosulfate pentahydrate, $Na_2S_2O_3 \cdot 5H_2O$
7. 200 mg methyl red indicator
8. 100 mg methylene blue indicator
9. 150 ml 95% ethyl alcohol, C_2H_5OH
10. 20 g. boric acid, H_3BO_3

CHECK LIST IV

Chemical Formulae:

Place the number from "consumable" list by the matching formula.

_____ a. $HBiO_3$

_____ b. $H_2B_4O_7$

_____ c. $NaOH$

_____ d. $Na_2S_2O_3$

_____ e. H_3BO_3

_____ f. CH_3OH

_____ g. $Na_2S_2O_3 \cdot 5H_2O$

_____ h. Hg_2O

_____ i. Hg_2SO_4

_____ j. $KHSO_4$

_____ k. HgO

_____ l. C_2H_5OH

_____ m. $Na_2S_2O_3 \cdot H_2O$

_____ n. K_2SO_4

_____ o. H_2SO_4

_____ p. $Na_2SO_3 \cdot 7H_2O$

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Care & Use of Equipment

LESSON NUMBER: 5 of 9

ESTIMATED TIME: 2 Hours

JUSTIFICATION: Chemical analyses requires the preparation and use of specialized equipment.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1, 3, and 4, Module II.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

a. Identify and operate

1) Vacuum system
2) Laboratory burner
3) Fume Hood
4) Laboratory Oven
5) Hotplate
6) Stirrer

b. Identify and use specific pieces of glassware as listed on pages 50 - 53 .
c. Clean glassware as per instruction sheet, page 54.

2. Conditions - Given a laboratory with all necessary glassware and equipment to include an oral presentation with demonstration of all equipment and glassware.

3. Accepted Performance - Performance of operations on equipment specified by instructor with 100% accuracy.

B. INSTRUCTIONAL RESOURCES

1. Available Media

4	534	2004	2016
204	594	2005	3014
285	671	2012	3025
289	2000	2013	

2. Suggested Media

Video Cassette demonstrating use of specific laboratory equipment.

C. INSTRUCTOR ACTIVITY

Having the student present in the laboratory, demonstrate the use of the following:

INSTRUCTOR NOTE: A comment concerning the SOJP Format of the Student Reference Manual should be given at this time.

1. Vacuum system. Show the differences between a vacuum pump, aspirator, and house vacuum.

2. Laboratory burner. Note the different types of burners such as Bunsen etc., and the various applications of each.

   a. Heating solutions
   b. Working with glass rods and tubing

3. Fume Hood. Include the type of fume hood. i.e.

   a. Suction type 50% - 50%
   b. Suction type 100%

   Note the importance of utilities such as gas, air vacuum and water present.

   Also use toxic or explosive chemicals in the fume hood. It should also be pointed out that the fume hood is never to be cluttered with debris.

4. Laboratory Oven

   a. Temperature Ranges
   b. Use of Asbestos Gloves.

5. Hotplate and Stirrer. Include the fact that these two items may be included in one.
   Also note that the temperature ranges are in the form of a rheostat rather than a thermometer.

D. STUDENT ACTIVITY

1. Discuss observations

2. Perform operations of the above equipment as noted by instructor.

E. INSTRUCTOR ACTIVITY

1. All pieces of glassware and hardware listed on pages 50-53, should be shown separately. The purpose and use should be noted.

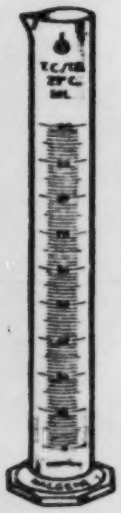
2. To insure that the student can use the glassware. It should be cleaned according to the procedure given on page 54.

1. STRAIGHT BURET

2. STRAIGHT BURET

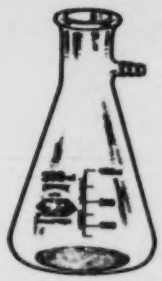
3. VOLUMETRIC PIPET

3.1 MOHR PIPET



4. GRADUATED CYLINDER

5. ERLENMEYER FLASK



6. SIDE ARM FLASK

7. VOLUMETRIC FLASK

8. CHEMICAL FILTERING FUNNEL

9. POWDER FILLING FUNNEL

10. SEPARATORY FUNNEL, WITH STOPPER AND TEFLON PLUG

11. BUCHNER FUNNEL

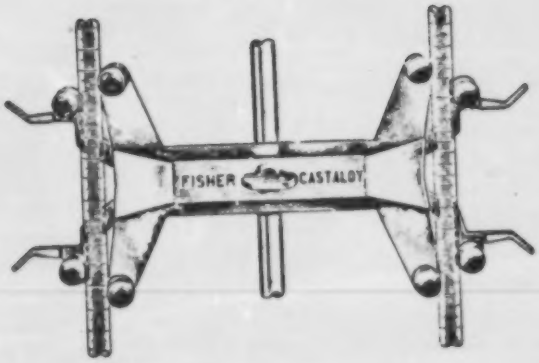
12. GOOCH CRUCIBLE (GLASS)

13. GOOCH CRUCIBLE (PORCELAIN)

14. WATCH GLASSES

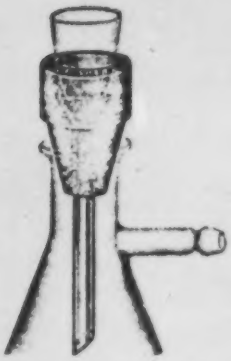
15. BEAKER

16. REAGENT STORAGE BOTTLES

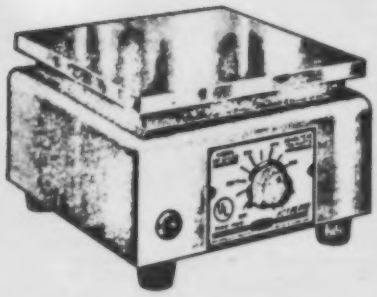


17. DOUBLE BURET CLAMP (CASTALOY)

18. CLAMP (COMBINATION UTILITY)

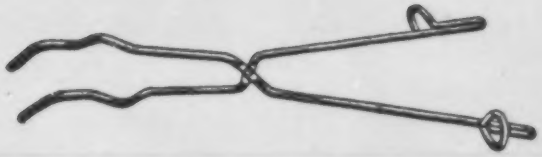


19. WALTER CRUCIBLE HOLDER



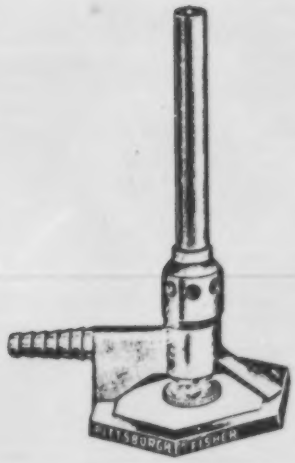
20. HOT PLATE

21. RING



22. TONGS

23. DESICCATOR



24. BUNSEN BURNER

GLASSWARE CLEANING

A piece of volumetric apparatus is sufficiently clean if its surface is uniformly wetted by distilled water. Oily contamination prevents glass walls from being uniformly wetted; drainage is then uneven and delivery is not precise. A general rule is to clean glassware immediately after use, since it is much more difficult to remove chemicals that have been allowed to cake and age.

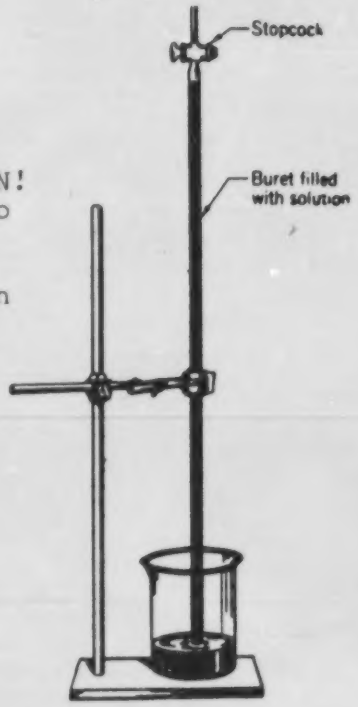
A volumetric flask, pipet, or buret that no longer drains uniformly is first rinsed thoroughly with tap water. The apparatus is then flushed with cleaning solution (CAUTION!!! - STRONG ACID - USE WITH CARE), the solution being kept away from the stopcocks so that the grease will not be removed. (A procedure for rinsing a buret with cleaning solution is shown below.) The cleaning solution is then rinsed out thoroughly with distilled water and the outside of the apparatus is wiped dry. To check cleanliness, the equipment is filled with distilled water and allowed to drain. If the water drains from the inner walls in a uniform film, the apparatus is clean; if the film coalesces into streams or droplets, further cleaning is necessary. After being allowed to drain for a few minutes, the equipment is stored with the inside undried. Burets are best stored in an upright position, filled well above the zero mark with distilled water. If this cannot be done in the restricted locker space, it is best to rinse again with cleaning solution just before use. Burets stored empty become contaminated with a grease film that spreads from the stopcock.

1. Place inverted buret in beaker containing cleaning solution.

2. Open stopcock and apply suction with aspirator bulb, drawing solution up into the buret. Fill almost to stopcock. CAUTION! Do not allow cleaning solution to contact the stopcock.

3. Close stopcock and allow solution to stand for a few minutes.

4. Open stopcock to allow cleaning solution to drain back into beaker.



Flushing a Buret with Cleaning Solution

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Matter

LESSON NUMBER: 6 of 9

ESTIMATED TIME: 2 Hours

JUSTIFICATION: To better understand the interaction of various chemicals, the makeup of matter is presented.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1-5, Module 5.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

   a. Give examples of the practical significance of the properties of solids, liquids, and gases.
   b. Note and observe volume change of liquids as temperature changes.
   c. Note and observe hygroscopic properties of substances.

2. Conditions - Given a lecture with demonstrations with the aid of the Student Reference Manual.

3. Accepted Performance - Satisfactory completion of demonstrations.

B. INSTRUCTIONAL RESOURCES

1. Available Media

443	2005	3014
447	2011	
507	3012	
594	3013	

2. Suggested Media - None.

C. INSTRUCTOR ACTIVITY

1. Develop the concept of physical states of matter and the physical and chemical properties of each.

   The associated demonstration should be performed when stated in the outline.

2. Physical States of Matter

   a. Matter can exist in 3 states - solid, liquid, and gas.

b. A specific substance can exist in more than one state, for example:

Water, CO_2, N_2, He, Iron, Hg, Cu

c. Matter can change spontaneously from one state to another.

3. Pertinent Properties of Each State

a. Physical Properties

1) Solid

a) Volume changes with temperature.
b) If heated it may melt, boil, vaporize, decompose or react with substances in the air.
c) Significance of these properties in the laboratory.

(1) Thermal shock when heating or cooling glassware.
(2) Change in volume of equipment used to measure accurate volumes.
(3) May emit toxic fumes if heated.

2) Liquid

a) Volume changes as temperature changes.
b) Will evaporate with the rate dependent on the specific substance. The boiling point indicates the relative tendency to evaporate.
c) Laboratory significance of these properties.

(1) When accurate volumes of liquids are required, the proper temperature condition must be observed. (Show pipette and volumetric flask) (Student Demonstration - I) page 61.
(2) Vapors from some liquids have a bad odor and/or are harmful and must be used in a well-ventilated room or work must be done in a fume hood.

(3) Spontaneous evaporation causes increase in pressure inside a closed container, thus popping stoppers.

(4) Do not store liquids with low boiling points near a source of heat.

3) Gas, Vapors, Fumes

a) Will fill the entire volume available.
b) Will change volume with temperature if possible, e.g., a balloon.
c) Will change pressure with temperature change if a volume change is not possible, e.g., Cl_2 in a cylinder.
d) Practical significance of these properties.

(1) If a liquid evaporates in one part of a room, the gas will fill the room, e.g., acid vapors, solvent vapors. (Instructor Demonstration - I) page 59.
(2) Heating a closed container may cause the container to burst.
(3) Cooling a closed container creates a vacuum inside which may cause container to break or be difficult to open, e.g., cooling a hot liquid in a volumetric flask, cooling in a desiccator.

e) The correct way to check odor of a chemical.

b. Chemical Properties

1) Solid

a) Hygroscopic substances
b) Increased hazard of spontaneous combustion as particle size decreases.
c) Reaction with water in the air to form new compounds.
d) Some solids decompose spontaneously, or if exposed to sunlight for prolonged periods.
e) Practical Significance:

(1) Hygroscopic substances change weight when exposed to wet (humid) air. Therefore you must use a desiccator for storage. (Student

Demonstration - II) page 60.

(2) If chemical stock bottles are left open, the chemical may be effected by the water in the air.

(3) Care must be taken to note the shelf-life of chemicals and observe storage requirements.

2) Liquids

a) May decompose spontaneously or if exposed to sunlight for prolonged period.

b) Significance of Property

(1) Observe shelf-life and storage requirements.

3) Gases, vapors, fumes

a) Vapors of different chemicals can react spontaneously (Chlorine & Ammonia HCL and NH_4OH) in the air.

b) Vapors can mix with air to form an explosive mixture.

c) Significance of properties

(1) Keep bottles of chemicals tightly closed. (Instructor Demonstration II) page 60.

(2) Do not store acids and bases next to one another.

(3) Do not work near an open flame with solvents.

(4) Do not smoke in the laboratory.

(5) Keep solvent bottles closed.

(6) Do not pour out large amounts of solvents into open containers.

D. STUDENT ACTIVITY

1. View Instructor Demonstrations and discuss observations.

2. Perform Student Demonstrations.

3. Take notes on material presented.

Instructor Demonstration - I Dissipation of Gases

Materials:

a. 1 open bottle of volatile acid or solvent

Procedure:

1. Open bottle and place in hood at beginning of lecture. Hood must be operating.

2. At time of demonstration point out open bottle and explain that hood has been on.

3. Turn off hood and measure the time that elapes before the person most distant from the hood smells the vapors.

Instructor Demonstration - II Reaction of Two Gases

Materials:

a. 5 ml hydrochloric acid, HCl, concentrated

b. 5 ml ammonium hydroxide, NH_4OH, concentrated

c. 2 porcelain dishes

Procedure:

1. Place HCl in dish
2. Place NH_4OH in dish
3. Place dishes side-by-side in a fume hood
4. Student must note the result

Student Demonstration - I Volume/Temperature dependence of liquids

Materials:

a. 3 250 ml (or 200 ml) volumetric flasks

b. Bunsen burner

c. 2 500 ml beakers

d. 1 metal trough

e. ice

f. 1 ring and ringstand

g. thermometer

Procedure:

1. Fill a 500 ml beaker with 300 ml of tap water and cool in ice bath.

2. Fill a 500 ml beaker with 300 ml of tap water and heat over a bunsen burner to 80°C (use thermometer).

3. Fill each volumetric flask to the base of the neck.

   a. 1 flask with cold water
   b. 1 flask with hot water
   c. 1 flask with room temperature water

   Use a squeeze-bottle to fill to the full mark.

4. Let all flasks come to room temperature and observe the level of the water in the flask.

Student Demonstration - II - Hygroscopic Substances

Materials:

a. 4 sodium hydroxide (NaOH) pellets in screw-cap bottle.

b. Porcelain dish containing dry sewage solids (stored in desiccator)

c. 1 clean, dry porcelain dish

Procedure:

1. Pour pellets into clean, dry porcelain dish and note appearance immediately

2. Remove dish with sewage solids from desiccator and note appearance immediately

3. Note appearance of substance after 15 minutes

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Solutions

LESSON NUMBER: 7 of 9

ESTIMATED TIME: 1 1/2 Hours

JUSTIFICATION: Chemical analyses requires the use of several types of solutions.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1 through 6 of Module II.

A. INSTRUCTIONAL OBJECTIVE(S)

1. Terminal Behavior - The student will:

a. List the general properties of solutions.

b. State the effect of temperature on the solubility of solids and gases in liquids.

c. State possible effects of dissolving chemical on the temperature of the solution.

d. Calculate the concentration of a solution in mg/l or ppm given the weight of solute in grams or milligrams and the volume of solvent in liters (or milliliters).

e. Recognize the letters N and M following numbers as indicating that the number is describing concentration.

2. Conditions

a. Given an oral presentation and a laboratory with all necessary chemicals and equipment.

3. Accepted Performance - Satisfactory response to oral questions and completion of concentration problems.

B. INSTRUCTIONAL RESOURCES

1. Available Media

204	443	507	2011	3013
404	477	594	3012	3014

2. Suggested Media

Video cassettes to demonstrate specific properties of solutions.

C. INSTRUCTOR ACTIVITY

1. Using the three physical states of matter, show the nine (9) types of solutions. Emphasize that only gas/liquid, liquid/liquid, and solid/liquid are applicable to the parameter being studied.

2. List the general properties of solutions such as:

   a. Saturated, unsaturated and supersaturated.
   b. Mixture (define).
   c. Homogeneous (salt and water).
   d. Heterogeneous (nonhomogeneous) (water and sand).

   c and d should be demonstrated at this time.

3. List the specific properties of solutions.

   a. Effect of temperature on gas/liquid solution. Heating decreases solubility; cooling increases solubility. Use dissolved oxygen and carbon dioxide (CO_2) as examples.
   b. Effect of temperature on solid/liquid and liquid/liquid solutions. Heating/cooling may increase or decrease solubility. Use $CuSO_4 \cdot 7H_2O$ or KNO_3 to illustrate an increase in solubility by heating. Use $MnSO_4 \cdot 7H_2O$ or $MnSO_4 \cdot H_2O$ to illustrate a decrease in solubility by heating.
   c. Effect of the dissolving process on temperature of the solution.
      A solid/liquid solution such as NaOH/water will increase the temperature of the solution.
      A $Na_2S_2O_3 \cdot 5H_2O$ solution will decrease the temperature of the solution.
      Emphasize safety aspects such as: Use of pyrex glass, and fume hoods.

4. Develop the concept of concentration by following the outline.

   a. The concept of "concentration"

      1) A description of the amount of solid, liquid or gas dissolved in a given volume of water.

a. con't.

2) Formal definition is: The weight of solid (liquid or gas) per volume of water.

3) Mathematical description is:

$$C = \frac{W}{V}$$

4) Give 3 examples by first giving written description of solution, then give mathematical description.

All weights are in (mg) and all volumes in (liters). All examples should ultimately have same concentration.
Leave examples on the chalkboard.

b. The formal statement of concentration.

1) The accepted way to describe concentration is with a simplified number and the units mg/liter or g/liter.

2) Illustrate by using the illustrations on the chalkboard and dividing numerator by denominator. The student will then see that all of the solutions were actually the same concentration.

EXAMPLES:

	Description of Solution	Basic Math Description of Concentration	Formal Concentration
I.	250 mg of NaCl dissolved in 1 liter of water	$\frac{250 \text{ mg}}{1 \text{ liter}}$	250 mg/liter
II.	500 mg of NaCl dissolved in 2 liters of water	$\frac{500 \text{ mg}}{2 \text{ liters}}$	250 mg/liter
III.	125 mg of NaCl dissolved in .5 liter of water	$\frac{125 \text{ mg}}{.5 \text{ liter}}$	250 mg/liter

3) The relationship between the units mg/liter and ppm.

4) Other units of concentration such as Normality (**N**) and Molarity (**M**).

D. STUDENT ACTIVITY

1. View Instructor Demonstration and discuss observations.

2. Take notes on material presented.

3. Respond to oral questions as presented.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Use of Laboratory Balances

LESSON NUMBER 8 of 9

ESTIMATED TIME 4 Hours

JUSTIFICATION: Chemical analyses requires the use of several types of balances.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1 through 7 of Module II.

A. INSTRUCTIONAL OBJECTIVES

1. Terminal Behavior - The student will:

   a. Identify and use a triple beam balance with a range of 0-100 g with an accuracy of ± 0.01 g.

   b. Identify and use an electric, top-loading balance with an accuracy of ± 0.01 g.

   c. Identify and use a double-pan analytical balance with an accuracy of ± 0.0001 g.

   d. Identify and use an automatic analytical balance with an accuracy of ± 0.0001 g.

   e. State precautions applicable to the care and use of all balances.

   f. The above should be performed with Gooch crucibles and applicable chemicals.

2. Conditions - Given any of the balances with appropriate reference material.

3. Accepted Performance - Weighing:

   a. A Gooch crucible to ± 0.0005 g. using the double pan analytical and single pan analytical balance.
   b. A salt sample to ± 0.05 g. using the top loading electric balance.

B. INSTRUCTIONAL RESOURCES

1. Available Media

534	2004	3014
699	2005	

C. INSTRUCTOR ACTIVITY

1. General Balance Rules

a. Treat all balances gently.
b. If the balance has an "arrest" mechanism, the balance must be in the "arrest position" when putting on or taking off substances to be weighed or the weights themselves.
c. Before weighing insure that the balance is level.
d. During a given experiment, use the same balance for all weighings.
e. Never weigh an object which is hot or even warm.
f. Never put chemicals directly on the balance pan. Use a piece of filter paper or an appropriate sized, clean, dry beaker.
g. If the balance is enclosed in a glass case, keep the case closed when taking the final weight.
h. Always "zero" the balance before beginning the weighing procedure.
i. After finishing a weighing procedure, remove all weights and put the "arrest mechanism" in position.

2. Types of Balances

a. Use of triple beam balance ($\pm$ 0.01 g accuracy)

1) Leveling
2) Finding zero-point by examining the "Swing"
3) Weighing procedure-demonstration with beaker
4) Effect of air currents
5) Number of decimal places in the result

b. Use of Analytical Balance ($\pm$ 0.0001 g accuracy)

1) Leveling balance
2) Parts of the balance (rider, chain, beam arrest, pan arrest)
3) Putting balance in "ready status"
4) Finding the zero-point by examining the swing. (If zero-point more than 3 divisions from center, adjust with adjusting screws on the beam)
5) Weighing procedure (demonstrate with beaker)

-Object on left pan, weights on right pan

-Keep door open while adding (or subtracting) weights on pan
-Use beam arrest at all times
-Add weight to pan to the nearest 1 gram
-Record digits to the right of decimal place
-Close door
-Determine weight to the nearest tenth of a gram with rider with beam arrest off and using only the pan arrest when moving the rider
-Record digit in tenths position
-With all arrest mechanisms off, move the chain so that the indicator swings evenly about the zero-point
(The pan arrest may be used to "quiet" the swing)
-Record the hundredths and thousandths digit from the movable metal strip (or dial or pointer) associated with the chain. Use the zero mark on the Vernier as the reference
-Record the ten-thousandths digit from the Vernier scale.
(Explain, if necessary what a Vernier scale does and how to read it. Give extra work on reading Vernier scale.)

6) Restate precautions on care and use of this balance.

c. Use of single pan, automatic, analytical balance. (Present such material as is necessary according to the Operation and Maintenance Manual for the specific balance.)
d. Use of top-loading, electric balance. (Present appropriate material from Operations and Maintenance Manual specific to the balance.)

3. The importance of reporting weights to the correct number of decimal places should be emphasized.

It should also be noted that the number of decimal places reflects the accuracy of the balance.

D. STUDENT ACTIVITY

1. View instructor demonstrations and discuss observations.

2. Weigh a Gooch crucible.

3. Determine the weight of a given quantity of NaCl by weighing into a beaker.

4. Obtain required accuracy, either ± 0.05 g or ± 0.0005 g depending on the type of balance used.

INSTRUCTOR NOTE: All crucibles to be used in this exercise should be preweighed by the instructor. The salt samples should be prepared in numbered vials (at least two per student will be needed).

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Chemical Laboratory

UNIT OF INSTRUCTION: Volumetric Analysis

LESSON NUMBER: 9 of 9

ESTIMATED TIME: 9 Hours

JUSTIFICATION: Chemical analyses requires the preparation and use of several types of standard solutions.

ENTRY LEVEL BEHAVIOR: Completion of Lessons 1 through 8 of Module II.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will accurately prepare:

a. 0.0375N Potassium Biiodate primary standard solution

b. 0.0375 N (Approximate) Sodium Thiosulfate Solution

c. 10% by volume Sulfuric Acid Solution

d. Magnesium Sulfate (Nutrient) Solution

2. Conditions - Given an oral presentation with all the necessary laboratory reagents and equipment.

3. Accepted Performance

a. Satisfactory preparation of all reagents as specified by the instructor.

b. Was able to attain acceptable precision in a titration analysis.

B. INSTRUCTIONAL RESOURCES

1. Available Media

4	699	2005	3014	3028
367	2004	2009	3027	

2. Suggested Media - CCTV cassettes on solution preparation.

C. INSTRUCTOR ACTIVITY

1. Define volumetric analysis. The concentration

of a solution is determined by the measurement of volumes.

2. Analyze the steps in a volumetric analysis.

   a. Preparation of the reagent.

   b. Preparation of the primary standard.

   c. Standardization of the reagent.

   A sodium thiosulfate standard solution will be prepared and standardized with a potassium biiodate standard. (See page 111 of the Student Reference Manual).

3. All points covered in the specific procedure should be reemphasized.

4. Common errors in a volumetric determination:

   a. Uncertainty in purity of the primary standard.

   b. Decomposition of the solution in standard.

   c. Changes in temperature.

   d. Careless laboratory technique.

   e. Errors in weighing.

   f. Mechanical losses of solution during titration or during transfer of solutions.

   g. Improper mixing of solutions.

   h. Dirty burets, pipets and other similar apparatus.

5. The correct procedure for titration should be reemphasized at this time.

6. In order to insure students ability in solution preparation, one or more of the reagents of the Dissolved Oxygen and/or Biochemical Oxygen Demand analysis should be prepared. These may be found in Ref. #2000, Section I.

D. STUDENT ACTIVITY

1. Take notes on material presented.

2. Discuss observations and demonstrations.

3. Prepare a standard solution and primary standard as directed.

4. Prepare a reagent for the BOD determination as directed:

INSTRUCTOR NOTE: A 0.75N stock solution of sodium thiosulfate should be available. If time permits a sample Dissolved Oxygen determination should be performed by the instructor using the students' reagents.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Microbiology

UNIT OF INSTRUCTION: Summary of Instruction on Microbiology

LESSON NUMBER: Total of 2

ESTIMATED TIME: 4 Hours

JUSTIFICATION: The NPDES requires bacteriological analyses.

ENTRY LEVEL BEHAVIOR: Completion of Module II.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will satisfactorily complete the two units of instruction on Microbiology.

2. Conditions - Given a lab with all necessary equipment, classroom instruction, and laboratory demonstrations where appropriate.

3. Accepted Performance - Satisfactory performance in the laboratory as measured by the instructor check lists.

B. INSTRUCTIONAL RESOURCES

1. Available Media

877	2000	3014
896	2017	

2. Suggested Media - Av material on general microbiological techniques.

C. INSTRUCTIONAL APPROACH (SEQUENCING)

Lesson I - General Introduction (1 Hour)
Lesson II - Laboratory (3 Hours)

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Microbiology

UNIT OF INSTRUCTION: General Introduction

LESSON NUMBER: 1 of 2

ESTIMATED TIME: 1 Hour

JUSTIFICATION: An understanding of the fecal coliform test requires a general introduction to Microbiology

ENTRY LEVEL BEHAVIOR: Completion of Module II..

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

a. Define the following terms: microbiology, pathogenic, bacteria, and coliform.

b. State why coliform organisms are used as indicator organisms.

2. Conditions - Oral presentation using the Student Reference Manual.

3. Accepted Performance - Satisfactory completion of written quiz (4/5 on closed book; 5/5 on open book).

B. INSTRUCTIONAL RESOURCES

1. Available Media

877	2000	3014
896	2017	

2. Suggested Media - AV material to show relationship to wastewater treatment.

C. INSTRUCTOR ACTIVITY

The instructor should describe the following with particular emphasis on the relationship to effluent monitoring.

1. Biology

a. Macrobiology
b. Microbiology

The study of small living organisms; microscopic organisms such as bacteria, yeasts, molds, algae, and protozoa; need microscope to see. Refer to SRM for size comparisons.

1) Microbe - a microscopic organism.
2) Germ - generally, refers to any microorganism but especially one that is pathogenic.
3) Pathogenic - disease-producing.
4) Microbe and germ are probably synonymous with bacteria.
5) Bacteria - the basic unit of plant life; single-celled microorganisms, widely distributed in nature; can be round, rod-shaped or spiral shaped.

2. Bacteriology

a. Description of bacteria

1) Bacteria are described by size and shape, growth requirements, temperature requirements, and oxygen requirements.

b. Impression is that all bacteria are harmful; in fact the great majority of bacteria are necessary for the existence of living things and only a few are harmful to man. Give examples of those that are beneficial.

c. The pathogenic bacteria:

1) Can be the causative agent of such diseases as cholera, typhoid fever, and dysentary.
2) These diseases are associated with the gastrointestinal tract and therefore fecal material.
3) The discharge of treated and/or untreated waste material, fecal in origin, can contain pathogenic organisms.
4) We take the helpful bacteria for granted, it is the pathogen we are concerned about.

d. Identification of pathogens:

1) Most pathogens are extremely difficult to isolate and identify.
2) We have indicator organisms - the coliform group of bacteria.
3) The coliform group of bacteria - those of fecal origin - can indicate the degree of fecal contamination and the presence or absence of pathogenic organisms.

4) Can identify the coliforms and all bacteria by their shape and how they act biochemically.
5) See how they react biochemically by growing in an environment they enjoy.
6) The environment we grow them in is called media.

3. Summary

a. Microbiology is the study of microscopic organisms.

b. The main concern of the wastewater treatment plant lab technician is the presence of fecal contamination.

c. Can check for presence of fecal contamination by checking for coliforms.

D. STUDENT ACTIVITY

1. Take notes on material presented.

2. Respond to oral questions as presented.

3. Completion of written quiz given at the end of Lesson 1.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Microbiology

UNIT OF INSTRUCTION: Laboratory Techniques

LESSON NUMBER: 2 of 2

ESTIMATED TIME: 3 Hours

JUSTIFICATION: Proper performance of the fecal coliform test requires proper microbiological laboratory techniques.

ENTRY LEVEL BEHAVIOR: Completion of lesson 1, Module III.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - The student will:

Describe and demonstrate methods of maintaining aseptic conditions with respect to inoculating loop, mouth pipet and sample transfer.

a. Prepare E.C. Media

b. Prepare fermentation tubes

c. Use inoculating loop

2. Conditions - Given necessary laboratory equipment, classroom instruction and demonstrations of all equipment and procedures to be used.

3. Accepted Performance - Instructor approval on preparation of media and tubes and use of inoculating loop.

B. INSTRUCTIONAL RESOURCES

1. Available Media

877	2000	3014
896	2017	

2. Suggested Media - None.

C. INSTRUCTIONAL ACTIVITY

1. Introduction of Microbiology Laboratory by using video tape, illustrating lab equipment.

a. Autoclave

b. Incubator

c. Hot Air Oven

d. Water Bath

e. Inoculating Loop

f. Pipet

g. Dilution Bottle

h. Fermentation Tubes

i. Bunsen Burner

2. Discuss disinfection and sterilization and the importance of maintaining aseptic conditions.

a. Disinfection - the killing or removing of agents which cause disease.

b. Sterilization - the destruction of absolutely all life.

Examples of physical agents for disinfection and sterilization.

1) Fire - the best sterilizing agent - Bunsen burner
2) Steam - for surface disinfection and where penetration desired.

a) Surface - no pressure, need contact for 30-40 minutes.
b) Steam generated in closed tank such as autoclave - contact for 20 minutes at 16 psi and 15 minutes at 20 psi - Sterilization.

3) Boiling - will disinfect in a few seconds, sterilization will require contact of 15 to 20 minutes.
4) Dry Heat - does not penetrate as well as steam and less effective than wet heat - 300°F will require 3 to 4 times as long as boiling.
5) Cold - not a disinfectant; it does prevent multiplication of bacteria; some pathogenic bacteria, such as typhoid, are stored this way.

INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: Laboratory Inventory

UNIT OF INSTRUCTION: Ordering Equipment and Supplies

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 1 Hour

JUSTIFICATION: Proper inventory procedures are necessary for any chemical laboratory

ENTRY LEVEL BEHAVIOR: Completion of Modules II and III.

A. INSTRUCTIONAL OBJECTIVE

1. Terminal Behavior - Given a list of chemicals and equipment, the student will be able to locate appropriate items in a scientific catalog. (See pages 82 & 83).

2. Conditions - Given chemical catalogs.

3. Accepted Performance - Completion of order form.

B. INSTRUCTIONAL RESOURCES

1. Available Media

Several Scientific Catalogs

2. Suggested Media - None.

C. INSTRUCTOR ACTIVITY

1. Show utility of choosing proper equipment and supplies.

2. Define and illustrate:

a. Capital equipment

b. Reusable supplies

c. Consumable supplies

3. Use specific catalogs to show equipment and chemicals.

4. Have students complete an order form given a sample list (pages 84 & 85).

D. STUDENT ACTIVITY

1. Discuss problems of ordering supplies.

2. Complete a sample order form.

Effluent Monitoring Procedure: Fecal Coliform Test by the Multiple Dilution Tube Method

General description of equipment and supplies used in the test analysis

Capital Equipment

Autoclave, providing uniform temperatures up to and including 121°C, equipped with an accurate thermometer, pressure gauges, saturated steam power lines and capable of reaching required temperature within 30 minutes.

Balance, 0.1 g sensitivity at load 160 g.

Air incubator to operate at 35°C ± 0.2°C and to accomodate tube racks as described separately.

Oven,*hot-air sterilizing, to give uniform temperatures and with suitable thermometer to register accurately in range of 160-180°C.

pH meter, accurate to at least 0.1 pH unit, with standard pH reference solution(s).

Water distillation apparatus (glass or block tin), or source of distilled water suitable for bacteriological culture media.

Reusable Supplies

Apron or coat suitable for laboratory

Baskets, wire for discarded cultures

Bottles, dilution*, 6-oz. screw caps, with 99ml volume level etched on one side.

Bottles, sample*, 250 ml (6-8 oz.), wide mouth, glass stopped preferred.

Bottle, squeeze type, with disinfecting solution

Burner, gas, Bunsen burner type

Cans, pipet, aluminum or steel; not copper. (If plastic, or other type of disposal pipet are used this item is unnecessary).

Metal caps* to fit 20 x 150 mm culture tubes

Jar, to receive discarded pipets.

Reusable Supplies

Inoculation loop, 3 mm diameter loop of nichrome or platinum-iridium wire, 26 B&S gauge, in holder.

Pipets*, 1 ml, with 0.1 ml graduations, Mohr type preferred, sterile, cotton plugged, glass or disposal plastic.

Racks, culture type* 10 x 5 openings, to accept tubes at least 20 mm in diameter.

Sponge, for cleaning desk top.

Tubes, culture*, 20 x 150 mm.

Tubes, fermentation*, 12 x 75 mm vials to be inverted in culture tubes.

Supplies Used Up in the Analysis (must be replaced when stocks get low)

Distilled water, suitable for bacteriological cultures (note distillation apparatus required in capital equipment).

EC Broth, Dehydrated (recommended purchase 1 - lb units).

Lactose Lauryl Sulfate Tryptose Broth, Dehydrated (Recommend purchase of 1 - lb units).

Potassium Dihydrogen Phosphate (KH_2PO_4) (recommend purchase of 1 - lb units).

Disinfectant, for bench tops. (Use household bleach solution prepared according to instructions on bottle).

Wax pencils (recommend soft wax equivalent to Blaisdell 169T)

*Items marked are needed in quantities or require size or space allowances which cannot be specified here, as they vary according to the daily analysis schedule. As a rule-of-thumb, space/size or quantity requirements should be at least 3 times the normal daily requirements. For further information on specifications for equipment and supplies, see the Microbiology Section of the current edition of "Standard Methods for the Examination of Water and Wastewater."

Name_____

ASSIGNMENT #1: Equipment and Supplies for Fecal Coliform Test Multiple Dilution Tube Method

Assume that you are responsible for the effluent monitoring tests for your treatment plant, which has an average daily flow of 18 mgd. In addition, you conduct the effluent monitoring tests for 2 small plants in your vicinity, each of which has an average daily flow between 1 and 4.99 mgd.

Prepare a purchase request, based on information in catalogues made available to you by your instructor, for the items shown below. (The amount should be enough to last one year. The size of fixed equipment should be appropriate to the amount of lab work required; assume that the sampling schedules will be set up to have the work from the surrounding laboratories come in on a scheduled basis to provide an even daily workload.)

Order: Wax pencils
EC Broth (dehydrated)
Fermentation Tube Assemblies
Autoclave

Minimum information in the purchase request should identify--

a. Yourself, as the originator of the request
b. The name of the item(s) requested
c. The size, and number of the item(s)
d. The cost per unit and the total cost for the item
e. The name of the catalogue from which you obtained the item, the stock number of each item selected from the catalogue, and any other identifying information that the purchasing officer should have.

Name_____

ASSIGNMENT #2: Equipment and Supplies for Fecal Coliform Test
Multiple Dilution Tube Method

Assume that you are responsible for the effluent monitoring tests for your treatment plant, which has an average daily flow of 45 mgd. In addition, you conduct the effluent monitoring tests for 3 small plants in your vicinity, each of which has an average daily flow between 1 and 4.99 mgd.

Prepare a purchase request, based on information in catalogues made available to you by your instructor, for the items shown below. (The amount should be enough to last one year. The size of fixed equipment should be appropriate to the amount of lab work required; assume that the sampling schedules will be set up to have the work from the surrounding laboratories come in on a scheduled basis to provide an even daily workload.)

Order: Pipettes
Lactose Lauryl Sulfate Tryptose Broth (dehydrated)
Water Bath Incubator
Laboratory Aprons or Coats

Minimum information in the purchase request should identify--

a. Yourself, as the originator of the request
b. The name of the item(s) requested
c. The size, and number of the item(s)
d. The cost per unit and the total cost for the item
e. The name of the catalogue from which you obtained the item, the stock number of each item selected from the catalogue, and any other identifying information that the purchasing officer should have.

Appendix I

TRAINEE APPLICATION FORM

COURSE TITLE_____

COURSE DATE_____

APPLICANT'S NAME_____

MAILING ADDRESS_____

CITY & STATE_____

EMPLOYER_____

TELEPHONE NO. EMPLOYER_____

TELEPHONE NO. RESIDENCE_____

OPERATOR CERTIFICATION HELD_____

YEARS EMPLOYED IN FIELD_____

LAST YEAR OF SCHOOL COMPLETED_____

DESCRIPTION OF YOUR PLANT PROCESS_____

_____

_____

DESCRIBE YOUR LABORATORY EXPERIENCE_____

_____

_____

DESCRIBE YOUR DUTIES_____

_____

_____

PARAMETERS REQUIRED OF YOUR PLANT (SEE YOUR PERMIT)_____

_____

_____

NOTICE: THIS APPLICATION MUST BE FILLED OUT PERSONALLY BY THE APPLICANT IN HIS OWN HANDWRITING.

MAIL TO: WILLIAM T. ENGEL, COURSE COORDINATOR
POLLUTION ABATEMENT TECHNOLOGY DIVISION
CHARLES COUNTY COMMUNITY COLLEGE
P.O. BOX 910
LA PLATA, MARYLAND 20646

Appendix II

EFFLUENT MONITORING PROCEDURES

BASIC LABORATORY SKILLS

Check-List of Student Performance

Student Name_____ Date_____

A. Safety

1. Located the following in the laboratory:

   a. Safety Shower
   b. Fire Extinguisher
   c. Fire Blanket
   d. Eye Wash
   e. First Aid Kit
   f. Fume Hood

   Yes_____ No_____

2. Given three emergency situations, responsed properly to all.

   Yes_____ No_____

B. Bench Sheets/Notebooks

1. Completed a sample bench sheet. Yes_____ No_____

C. Labeling

1. Prepared a label for a chemical stock bottle.

   Yes_____ No_____

D. Names and Formulas of Compounds

1. Completed the four check-lists. Yes_____ No_____

2. Using the four consumable supply lists, selected reagents with 100% accuracy.

   Yes_____ No_____

E. Care and Use of Equipment

1. Accurately identified and used the following:

   a. Buret Yes_____ No_____

   b. Mohr Pipet Yes_____ No_____

c. Volumetric Pipet Yes_____ No_____

d. Volumetric Flask Yes_____ No_____

2. Accurately identified and used the common laboratory glassware:
Yes_____ No_____

3. Accurately identified and used the common laboratory equipment:
Yes_____ No_____

4. Cleaned Volumetric Glassware with Chromic Acid Cleaning Solution:
Yes_____ No_____

F. Matter

1. Completed the student demonstrations:
Yes_____ No_____

2. Recorded results in the laboratory notebook:
Yes_____ No_____

G. Solutions

1. Calculated various concentrations of solutions:
Yes_____ No_____

H. Balances

1. Accurately operated the following:

a. Double-pan analytical balance: Yes_____ No_____

b. Single-pan analytical balance: Yes_____ No_____

c. Triple-beam balance: Yes_____ No_____

d. Top-loading electric balance: Yes_____ No_____

2. Determined the weight of an unknown Gooch crucible to ±0.0005 g, using the double-pan analytical and single-pan analytical balance:
Yes_____ No_____

H. Balances con't.

3. Determined the weight of an unknown salt sample to ± 0.02 g, using the top-loading electric balance:

Yes_____ No_____

I. Volumetric Analysis

1. Accurately prepared the following solutions:

a. 0.0375N Potassium Biiodate Primary Standard Solution:

Yes_____ No_____

b. 0.0375N (approximate) Sodium Thiosulfate Solution:

Yes_____ No_____

c. 10% by volume Sulfuric Acid Solution:

Yes_____ No_____

d. Magnesium Sulfate (Nitrient) Solution:

Yes_____ No_____

2. Accurately performed the standardization of thiosulfate with the primary standard:

Yes_____ No_____

3. Calculated the normality (N) of the Sodium Thiosulfate:

Yes_____ No_____

J. Microbiology

1. Properly used an innoculation loop:

Yes_____ No_____

2. Accurately prepared E.C. Media: Yes_____ No_____

3. Accurately prepared fermentation tubes:

Yes_____ No_____

4. Satisfactorily completed written quiz:

Yes_____ No_____

K. Ordering Equipment and Supplies

1. Completed a purchase order as per exercise:

Yes_____ No_____

APPENDIX III

INSTRUCTIONAL MATERIALS cont.

IDENTITY NUMBER	TITLE	AUTHOR	TYPE OF MATERIAL	INTENDED AUDIENCE	DESIGNED USAGE	SOURCE	COST
519	Working with Numbers	J.T. Shea	PM	IO	I	SVC	2.00
534	Laboratory Procedures for Wastewater Treatment Plant Operators	NY Dept. Health	PM	BO	I	HES	1.25
594	Chemistry	EPA	OT	BO	I	EPA-R4A	Free r
620	Mathematics, Vol. I (0847-0082) 1966 (D208.11:M4212/V1/966)	USN	PM	IO	I	GPO	1.50
627	Mathematics, Vol. 2 (0847-0083) 1968 (D208.11:M42/2/V2/966)	USN	PM	IO	I	GPO	1.75
671	Laboratory Procedures for Wastewater, Analysis (No. 3)	NERWI	PM	IO	I	NERWI	Free
689	Instruction in Wastewater Mathematics for Operators of Wastewater Treatment Plants	NERWI	PM	BO	I	NERWI	Free
698	Methods for Chemical Analysis of Water and Wastes (5501-0067) 1967 (SbYEP2.10: 16020/01/71)	EPA	PM	IO	I	GPO	3.00
699	Laboratory Procedures	Nagano	PM	IO	I,G	CWPCA	4.00
877	Microorganic Matter in Water (STPub 448)	ASTM	PM	AO	I	ASTM	9.25
896	Water Pollution Microbiology	R. Mitchell	PM	AO	I	WI	19.50

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APPENDIX III

INSTRUCTIONAL MATERIALS cont.

IDENTITY NUMBER	TITLE	AUTHOR	TYPE OF MATERIAL	INTENDED AUDIENCE	DESIGNED USAGE	SOURCE	COST
—2000	Self Monitoring Procedures: Basic Parameters for Municipal Effluents	EPA - 2	PM	BO, IO AO, M	I	EPA -2	----
—2001	ASTM Manual Part 23	ASTM	PM	BO, IO AO, M	I	ASTM	35.75
2002	Mathematics, A Basic Course	Dever & Salten	PM	BO, IO	I	CAM	?
2003	Metric Conversion Table	GPO	PM	BO, IO AO, M	I	GPO	0.25
—2004	Modern Chemical Technology Guidebook	ACS	PM	BO, IO	I	ACS	?
2005	Chemical Principles in the Laboratory	Malm & Frantz	PM	BO, IO AO, M	I	WHF	4.50
2006	Current Practices in Water Microbiology	EPA - 2	PM	BO, IO AO, M	I	EPA	----
2007	Basic Mathematics Vol. I-V	Daniel Borrow	PM	BO, IO	I	EBEC	?
2008	A Guide to Remedial Instruction in Basic Mathematics	Gay, Count, Ponder	PM	BO, IO	I	GREEN	----
2009	Safety in the Chemical Laboratory	Norman Steele	PM	BO, IO AO, M	I	CHED	6.50
2010	Chemistry for Laboratory Technicians	Stanley Cherim	PM	BO, IO AO, M	I	WBS	?
2011	College Chemistry	Nebergall Schmidt Holtzclaw	PM	BO, IO AO, M	I	PCH	?

APPENDIX III

INSTRUCTIONAL MATERIALS cont.

IDENTITY NUMBER	TITLE	AUTHOR	TYPE OF MATERIAL	INTENDED AUDIENCE	DESIGNED USAGE	SOURCE	COST
2012	Common Laboratory Apparatus (811)	CSC	SL, AT	BO, IO	I	CSC	35.00
2013	Pipetting Techniques (812)	CSC	SL, AT	BO, IO	I	CSC	35.00
2014	Metric System of Linear Measure (821)	CSC	SL, AT	BO, IO	I	CSC	35.00
2015	Volume and Mass (822)	CSC	SL, AT	BO, IO	I	CSC	35.00
2016	How to Titrate Using a Burette (8105)	CSC	SL, AT	BO, IO	I	CSC	25.00
2017	Current Practices in Water Microbiology	EPA	PM	BO, IO AO, M	I	EPA	----
3001	Water Chemistry -- Laboratory Manual	AEEP	PM	AO	I	AEEP	15.00
3009	Elementary Mathematics and Basic Calculations	Eglof & Swope	PM	BO	I	WSW	1.00
3010	Water and Wastewater Work Book Series/1 Operator Short Course	G. Chanin	PM	IO	I	WWE	3.00
3012	General Chemistry Minicourses Vol 1--Preliminary Edition	J.F. Allen	PM	IO	I	BPC	6.50
3013	General Chemistry Minicourses Vol 2--Preliminary Edition	J.F. Allen	PM	IO	I	BPC	6.95
3014	Self Monitoring Procedures: Basic Laboratory Skills	CCCC	PM	BO, IO	I	EPA - 2	----
3015	Safety in the Laboratory	KM	MP-16	BO,IO	I,G	KM	87.25
3016	Handbook of Laboratory Safety	CRC	PM	BO, IO, AO, M	I	CRC	----

IDENTITY NUMBER	TITLE	AUTHOR	TYPE OF MATERIAL	INTENDED AUDIENCE	DESIGNED USAGE	SOURCE	COST
3017	Safety Practice for Chemical Laboratories	VP	PM	BO, IO AO, M	I	VP	----
3018	Chemical Safety Information Systems	NSC	PM	BO, IO	I	NSC	----
3019	Fire Protection Guide on Hazardous Materials	NFP	PM	BO, IO	I	NFP	----
3020	List of Toxic Substances (OSHA) Occupational Safety and Health Reporter. Reference File 74:0001, pg. 11-272	BNA	PM	BO, IO	I	BNA	----
3021	Chemical and Biological Safety Guide	NIH	PM	BO, IO	I	NIH	----
3022	National Electrical Code Volume 5	NFPA	PM	BO, IO	I	NFPA	----
3023	Safety and Accident Prevention in Chemical Operations	WI	PM	BO, IO	I	WI	----
3024	Modu-Math Video Cassette Math Course	SUNY	VT-1/2	BO	I, G	SUNY	$721.50
3025	The Buret (Basic Principles) TC-5	EPA - 2	VT-1/2	BO	I, G	EPA - 2	----
3026	Microbiological Principles TC-12	EPA - 2	VT-1/2	BO	I, G	EPA - 2	----
3027	Winkler Determination of Dissolved Oxygen	EPA - 2	VT-1/2	BO, IO	I, G	EPA - 2	----

APPENDIX III

INSTRUCTIONAL MATERIALS cont.

IDENTITY NUMBER	TITLE	AUTHOR	TYPE OF MATERIAL	INTENDED AUDIENCE	DESIGNED USAGE	SOURCE	COST
3028	Standardization of Sodium Thiosulfate	EPA - 2	UT-1/2	BO, IO	I, G	EPA - 2	----

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APPENDIX III A

ADDITIONAL SOURCE LISTINGS

SOURCE	TITLE
OKBS	Oklahoma State University Book Store Stillwater, Oklahoma 74074
BPC	Burgess Publishing Company 7108 Ohms Lane Minnesota 55435
SDA	The Soap and Detergent Association 475 Park Avenue South New York, New York 10016
CuSC	Marketing Department Curtin Scientific Company P.O. Box 1545 Houston, Texas 77001
InNi	The International Nickel Co., Inc. 1 New York Plaza New York, New York 10004
CVM	C. V. Mosby Company 11830 Westline Industrial Drive St. Louis, Missouri 63141
AEEP	AEEP c/o Dr. Joe Molina Director of Environmental Health Engineering 305 Engineering Building University of Texas Austin, Texas 78712
WHF	W.H. Freeman & Co. San Francisco, California
GREEN	Greenville Technical Education Center Greenville, South Carolina
CAH	Cambridge Book Co. New York, New York
ACS	American Chemical Society 1155 16th Street, NW Washington, D.C. 20036

APPENDIX III A

ADDITIONAL SOURCE LISTINGS

SOURCE	TITLE
CHED	Division of Chemical Education American Chemical Society Easton, Pa. 18042
DCH	D. C. Health & Company Lexington, Massachusettes
CCCC	Charles County Community College P.O. Box 910 La Plata, Maryland 20646
KM	Kalmia Co. Concord, Mass. 01742
CRC	Chemical Rubber Co. Cleveland, Ohio
VP	Villanova Press Villanova, Pa.
NSC	National Safety Council 425 N. Michigan Avenue Chicago, Ill. 60611
NFP	National Fire Protection Association 60 Batterymarch Street Boston, Mass. 02110
BNA	Bureau of National Affairs, Inc. 1231 25th Street, N.W. Washington, D.C. 20037
NIH	National Institute of Health Safety and Fire Prevention Branch Bethesda, Maryland 20014
NFPA	National Fire Protection Association 60 Batterymarch Street Boston, Mass. 02110
WI	Wiley Interscience John Wiley & Sons Inc. 605 Third Avenue New York, New York 10016

APPENDIX III A

ADDITIONAL SOURCE LISTINGS

SOURCE	TITLE
SUNY	New York Network A.E. Smith Office Building 12th Floor Albany, New York 12225 Attention: Mr. Dan Sweeney
EPA - 2	Ms. Eileen Hopewell EPA National Training Center Cincinnati, Ohio 45268

Appendix IV

BASIC MATHEMATICS

PRE - TEST

1. Given the following table, list one Metric and one English unit for the listed measurements.

	METRIC	ENGLISH
Weight	_____	_____
Length	_____	_____
Volume	_____	_____
Temperature	_____	_____

2. State the numerical value for the following metric prefixes.

Kilo _____

Centi _____

Milli _____

---

3. Add:

$$\begin{array}{r} 156 \\ +\ 24 \\ \hline \end{array} \qquad \begin{array}{r} 79 \\ +62 \\ \hline \end{array}$$

4. Subtract:

$$\begin{array}{r} 50 \\ -12 \\ \hline \end{array} \qquad \begin{array}{r} 262 \\ -\ 79 \\ \hline \end{array}$$

5. Multiply:

205 x 82 =

98 x 17 =

642 x 8 x 3 =

(24) (7) =

6. Divide:

13,888/124

966/23

---

7. Round the following to the nearest ten:

(a) 47
(b) 912

8. Round the following to the nearest hundred:

(a) 847
(b) 75,619

---

9. Add:

$$\begin{array}{r} 0.269 \\ 4.2 \\ 24 \\ +\ 1.04 \\ \hline \end{array} \qquad \begin{array}{r} 59.6 \\ +\ 0.37 \\ \hline \end{array}$$

10. Subtract:

$$\begin{array}{r} 12.6 \\ -\ 0.8 \\ \hline \end{array} \qquad \begin{array}{r} 27.3 \\ -\ 4.9 \\ \hline \end{array}$$

11. Multiply:

2.35 x 0.05 =

(45.38) (1,000) =

12. Divide:

25.8/3.9

615.6/1.5

---

13. Round off to the nearest tenth:

(a) 8.9074
(b) 3.26

14. Round off to the nearest thousandth:

(a) 94.66241
(b) 0.5358

---

15. Given A = (B - C)/D. Find A when B = 24.6239
C = 24.5197
D = 10

16. Given A = B x C/D. Find A when B = 6.4
C = 7.9
D = 3.2

---

17. Express the following as percentages.

(a) 0.05
(b) 0.79

18. Calculate the following and express answers as percentages.

(a) $\frac{300 - 24}{300}$ =

(b) $\frac{220 - 19}{220}$ =

Appendix V

MODULE I - QUIZZES

QUIZ I

METRIC SYSTEM

Name_____

1. Given the following table, list one Metric and one English unit for the listed Measurements.

	METRIC	ENGLISH
Weight	_____	_____
Length	_____	_____
Volume	_____	_____
Temperature	_____	_____

2. State the numerical value for the following Metric prefixes.

Kilo _____

Centi _____

Milli _____

QUIZ II

WHOLE NUMBERS

Name _____

1. Perform the indicated operations.

156 gms	79 gms	50 ml	262 gms
+ 24 gms	+62 gms	-12 ml	- 79 gms

642 x 8 x 3 =

(24) (7) =

224/2 =

1368/3 =

2. Round the following to the nearest ten:

(a) 47
(b) 912

3. Round the following to the nearest hundred:

(a) 847
(b) 75,619

QUIZ III

DECIMALS

Name_____

1. Round off to the nearest tenth:

   (a) 8.9074

   (b) 3.26

2. Round off to the nearest thousandth:

   (a) 94.66241

   (b) 0.5358

3.
```
  0.269
  4.2
 24
+ 1.04
```

4. 0.05 x 2.35 =

5. (45.38) (1,000)

6. 25.8/3.9 =

7. 12.6 - 0.8 =

8. 27.3 - 4.9 =

QUIZ IV

FORMULAS

Name_____

1. Given $A = \frac{(B-C)\ (1{,}000)}{D}$. Find A when B = 24.6239 g
   C = 24.6197 g
   D = 50 ml

2. Given A = B x C/D. Find A when B = 20.0 ml
   C = 0.0375 N
   D = 15.0 ml

QUIZ V

PERCENTAGES

Name_____

1. Express the following as percentages.

   (a) 0.05

   (b) 0.79

2. Calculate the following:

   (a) $\frac{300 - 24}{300}$ =

   (b) $\frac{220 - 19}{220}$ =

Express answers as percentages.

Appendix VI

MODULE III - MICROBIOLOGY

EVALUATION

NAME_____

COMPLETE THE FOLLOWING STATEMENTS:

1. Microbiology is the study of _____

2. The term "pathogenic" refers to_____ organisms.

3. Bacteria are _____

_____

4. The coliform organisms are used to _____

_____

5. Disinfection is _____

_____

6. Sterilization is_____

_____

7. Two physical agents of disinfection are _____

and_____

8. Two chemical agents of disinfection are _____

and_____

9. The maintenance of_____

conditions is of major importance when performing microbiological analysis.

10. Use of the_____

and_____will help maintain aseptic conditions in the laboratory.

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